Measurement of Immersion Freezing Nuclei in Antarctica

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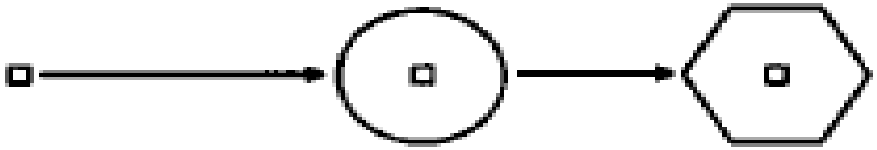
Heterogeneous Freezing

Deposition freezing

Condensation freezing



Contact freezing

Immersion freezing

Rogers and Yau (1989)

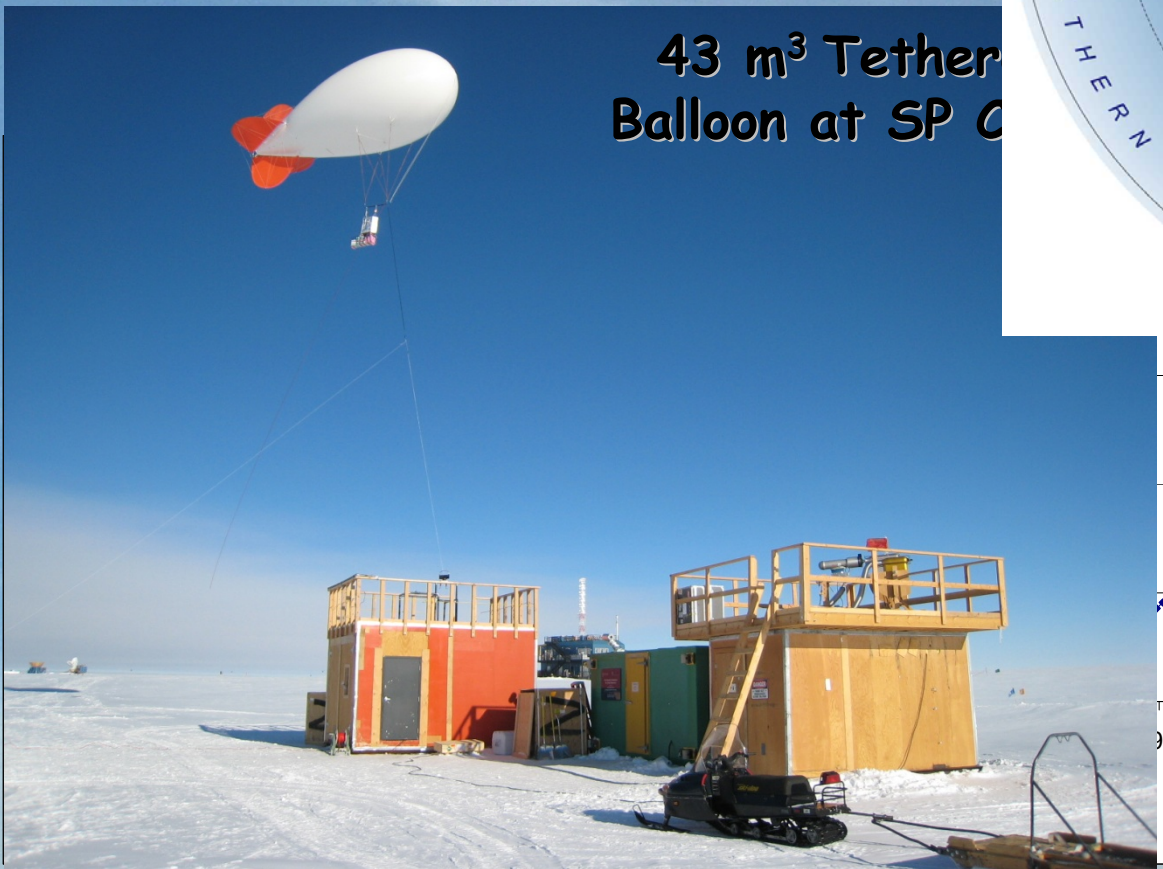
Project objectives:

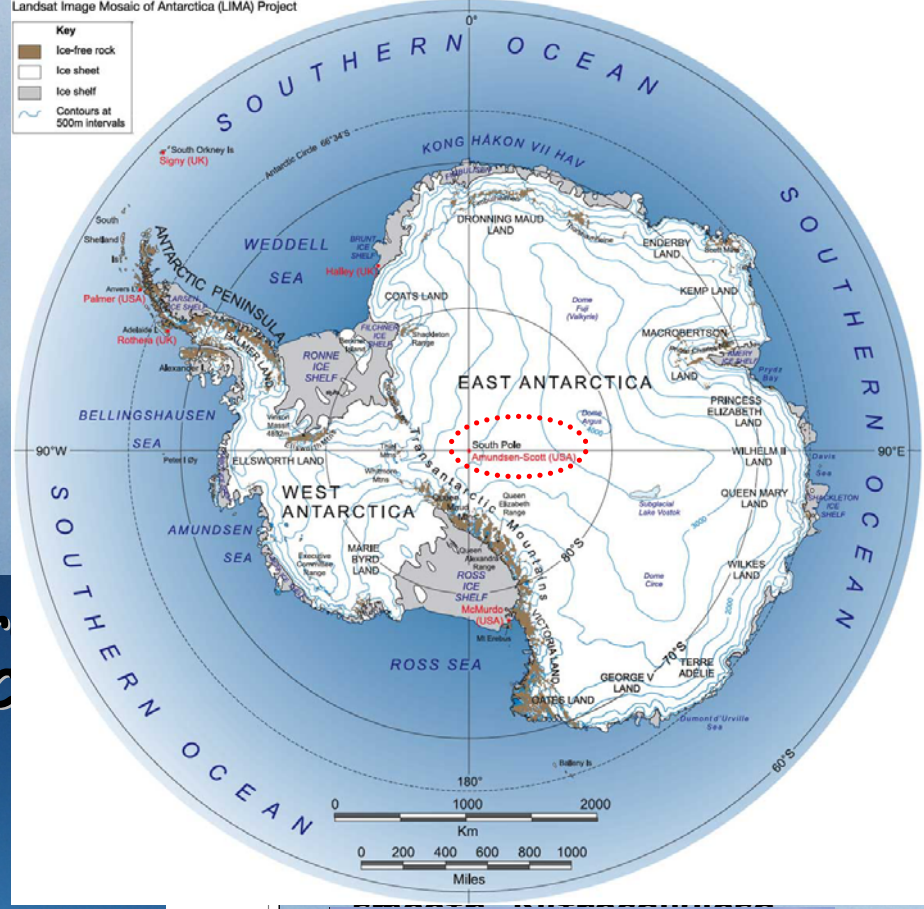
The objective of the whole project was to investigate the background aerosol concentrations in Antarctica and their effect on solar radiation.

Our part was to determine the immersion freezing nuclei concentrations.

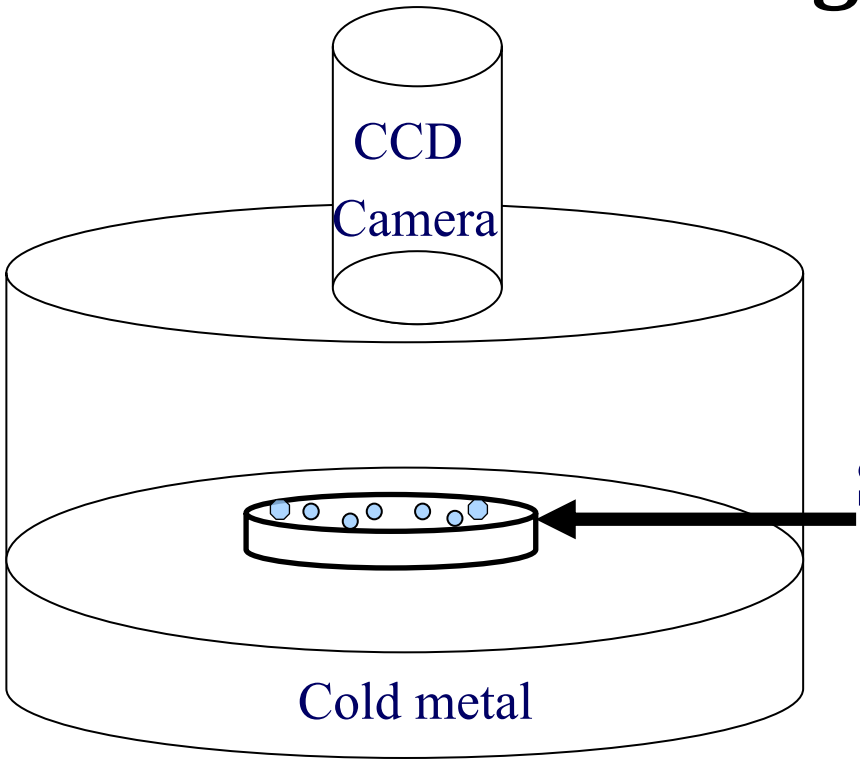
Our colleagues in Frankfurt analyzed samples of aerosols for their nucleation of ice by condensation freezing and deposition freezing.

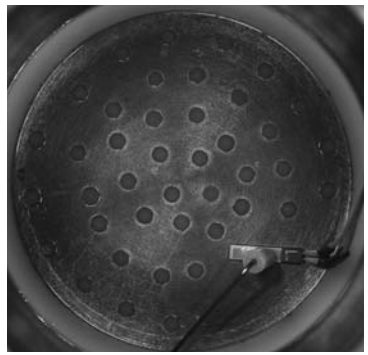
Amundsen-Scott South Pole Station



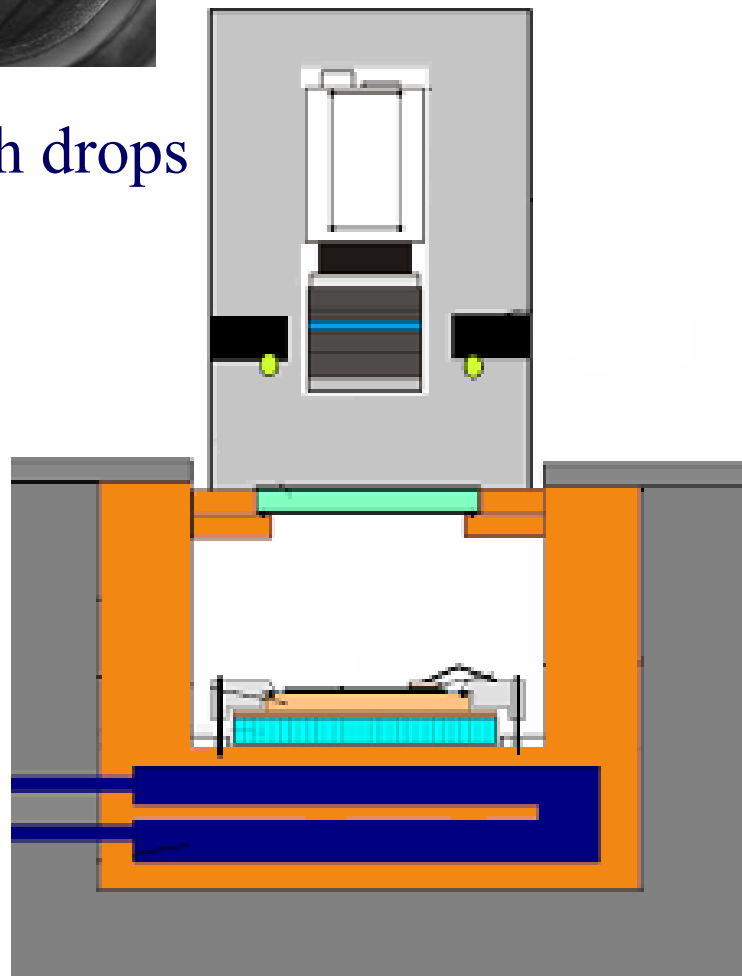


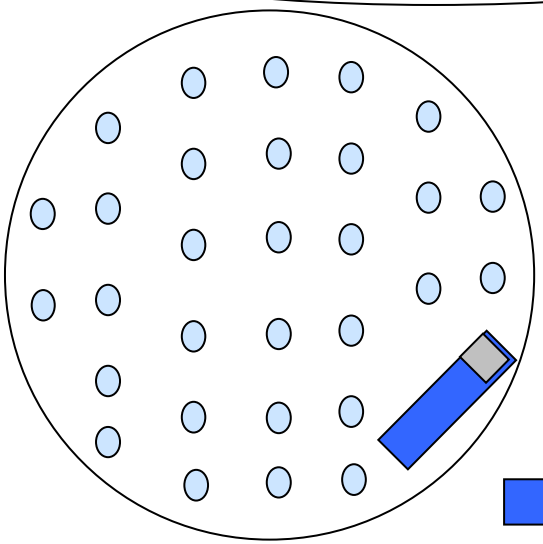
Immersion freezing in the FRIDGE-TAU





Stage with drops

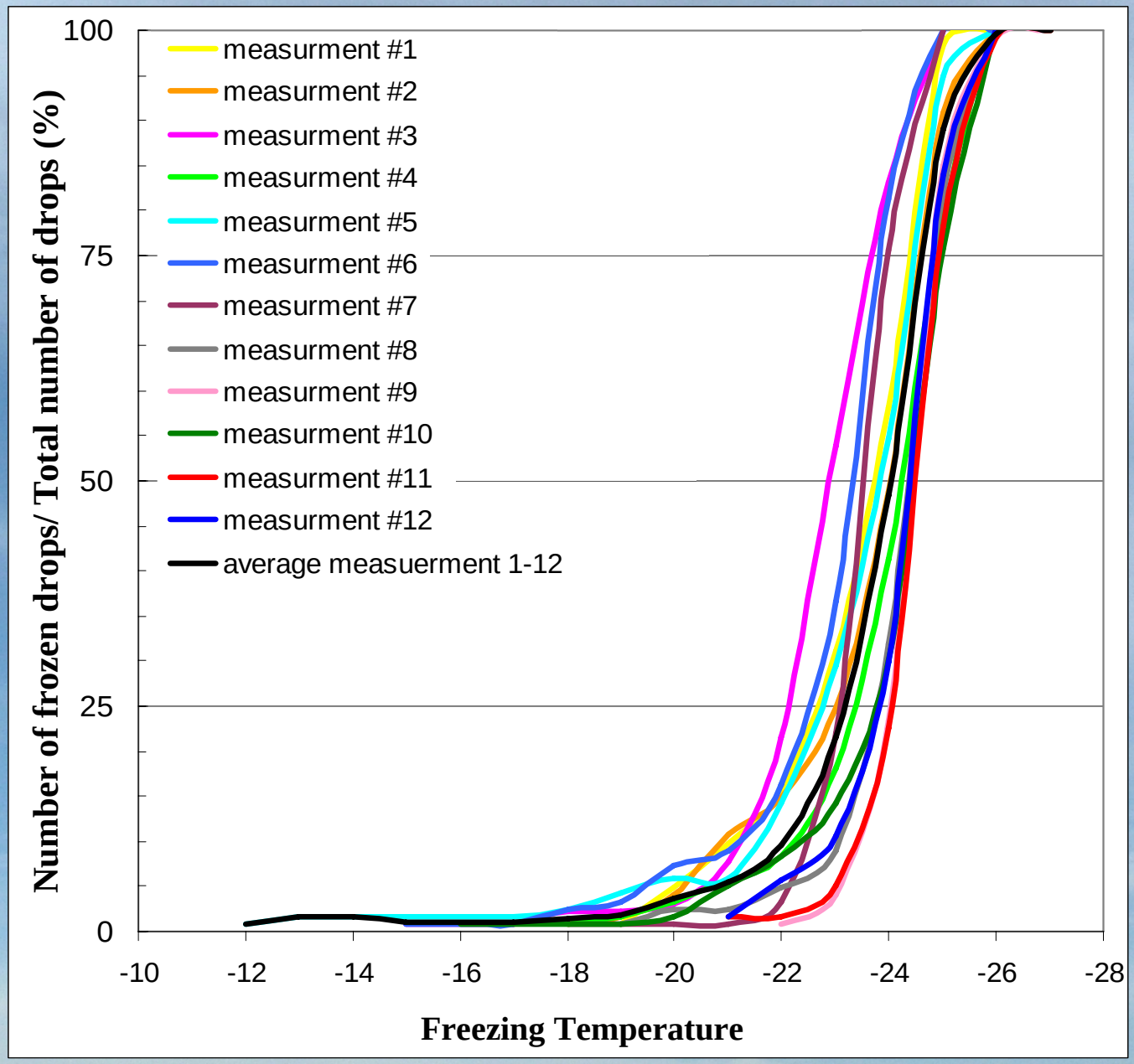




Stage with drops

-Thermometer

Immersion Freezing



Calculation of the concentrations of Immersion Freezing nuclei in the air (#/L) - modified from Vali (1971):

$$K'(\theta) = \frac{1}{V} * \left[\ln(N_0) - \ln(N(\theta)\right] * \frac{x}{y}$$

$K'(\theta)$ – Cumulative concentration of FN in the air, active at temperature θ (#/L)

V – Volume of drop (cm^{-3})

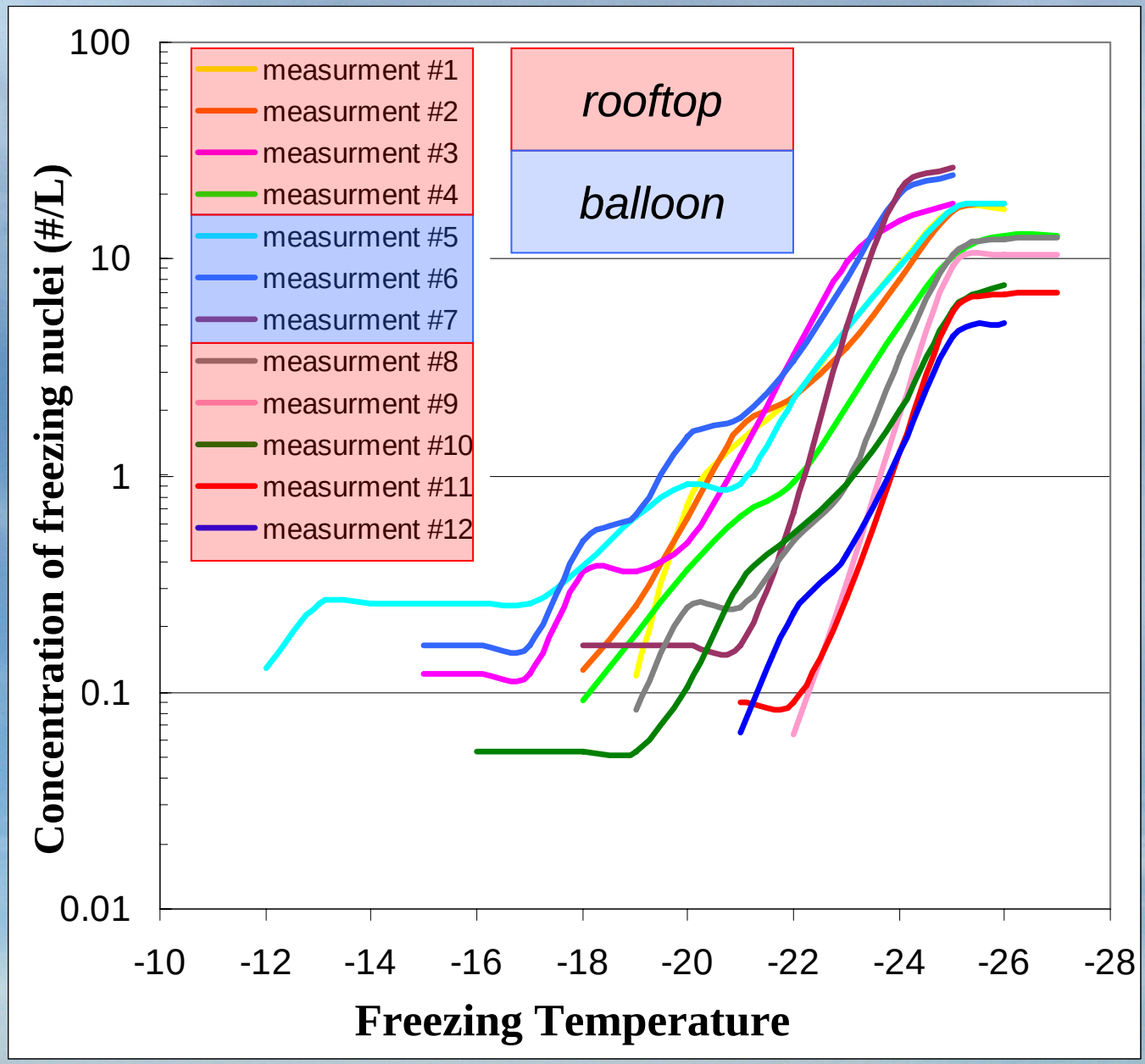
No – Total number of measured drops

N (θ) – Number of unfrozen drop at temperature θ

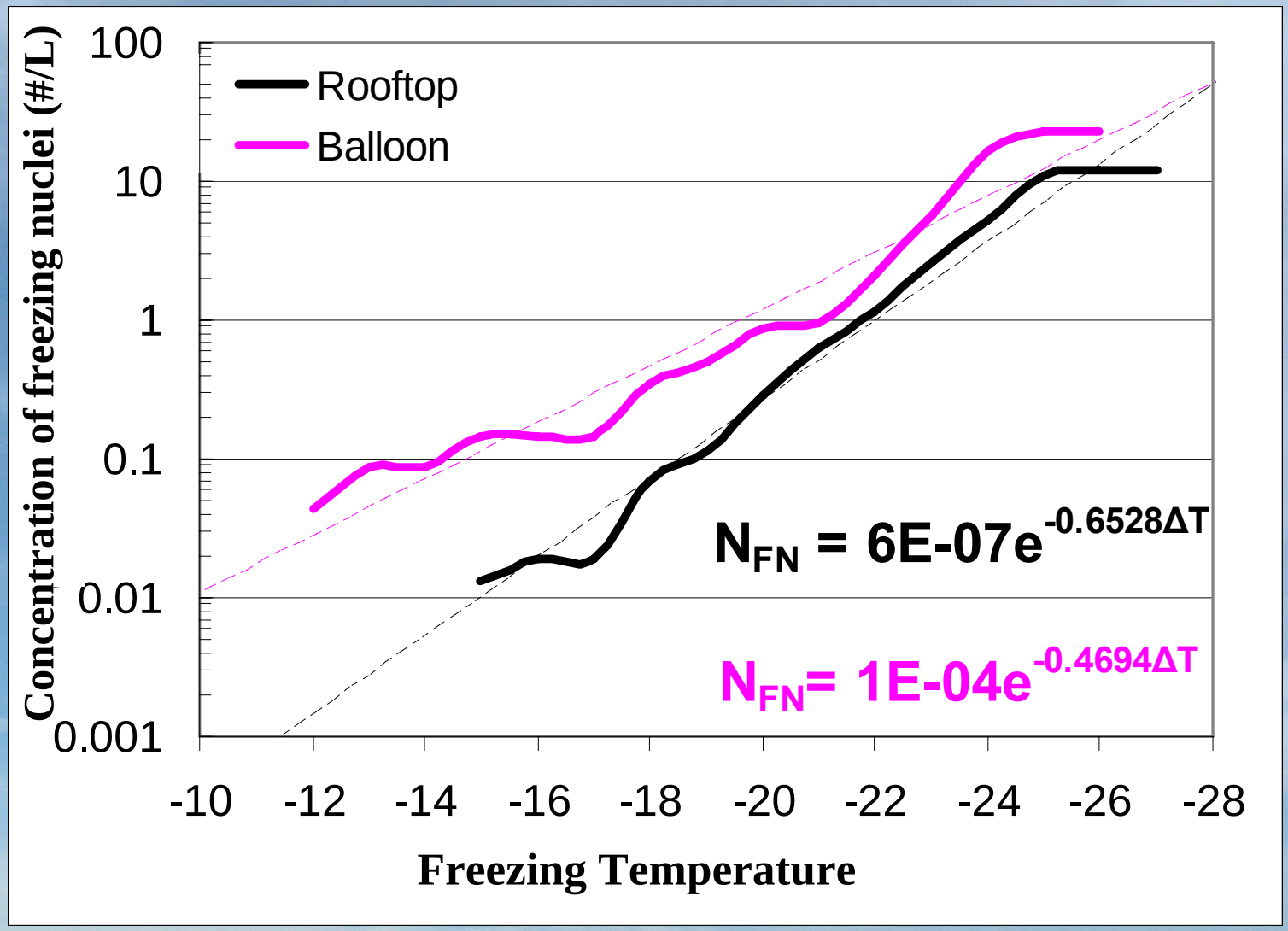
x – The volume of water used to remove the aerosols from the filter (L)

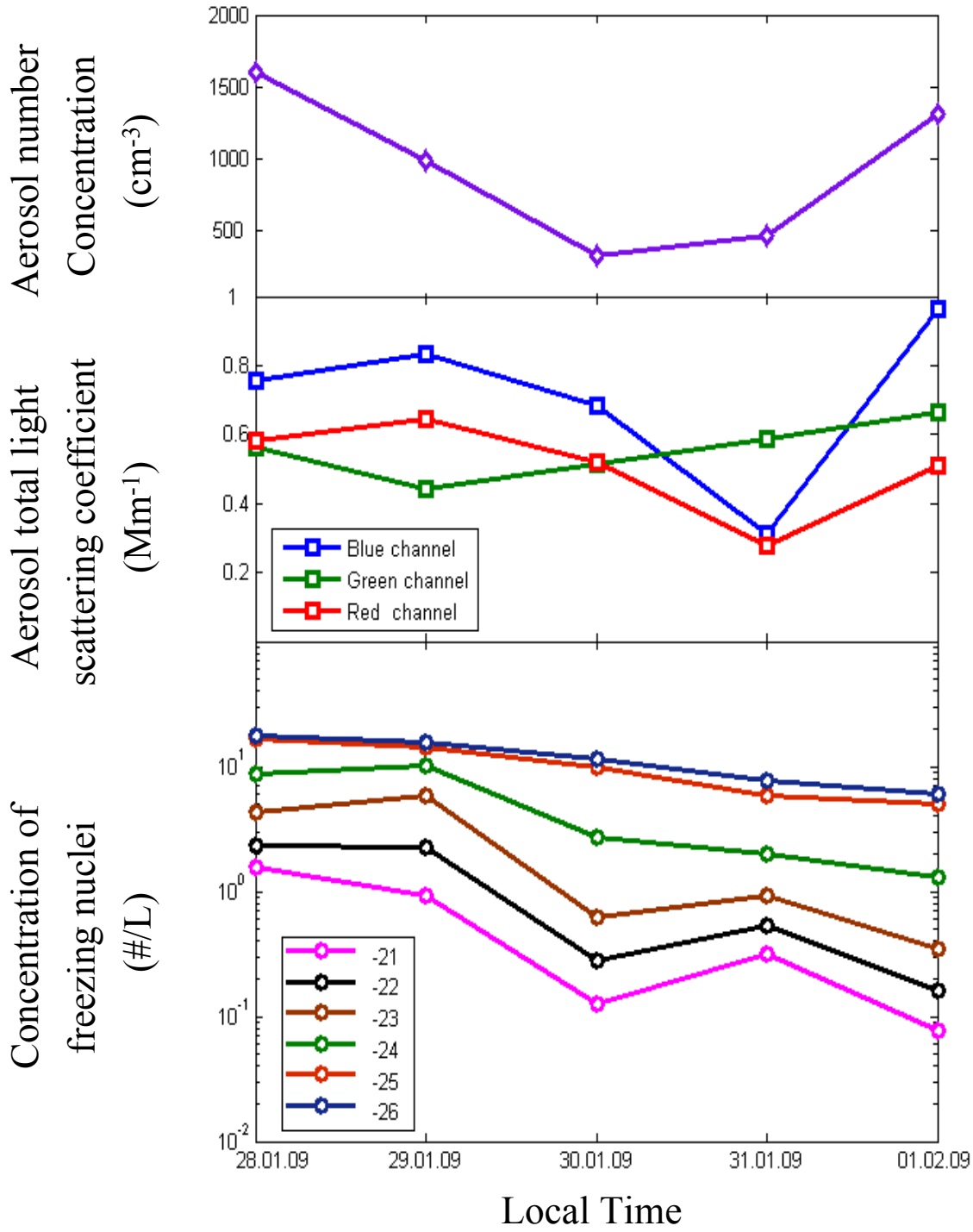
y – The volume of air sampled through the filter (L)

Immersion Freezing



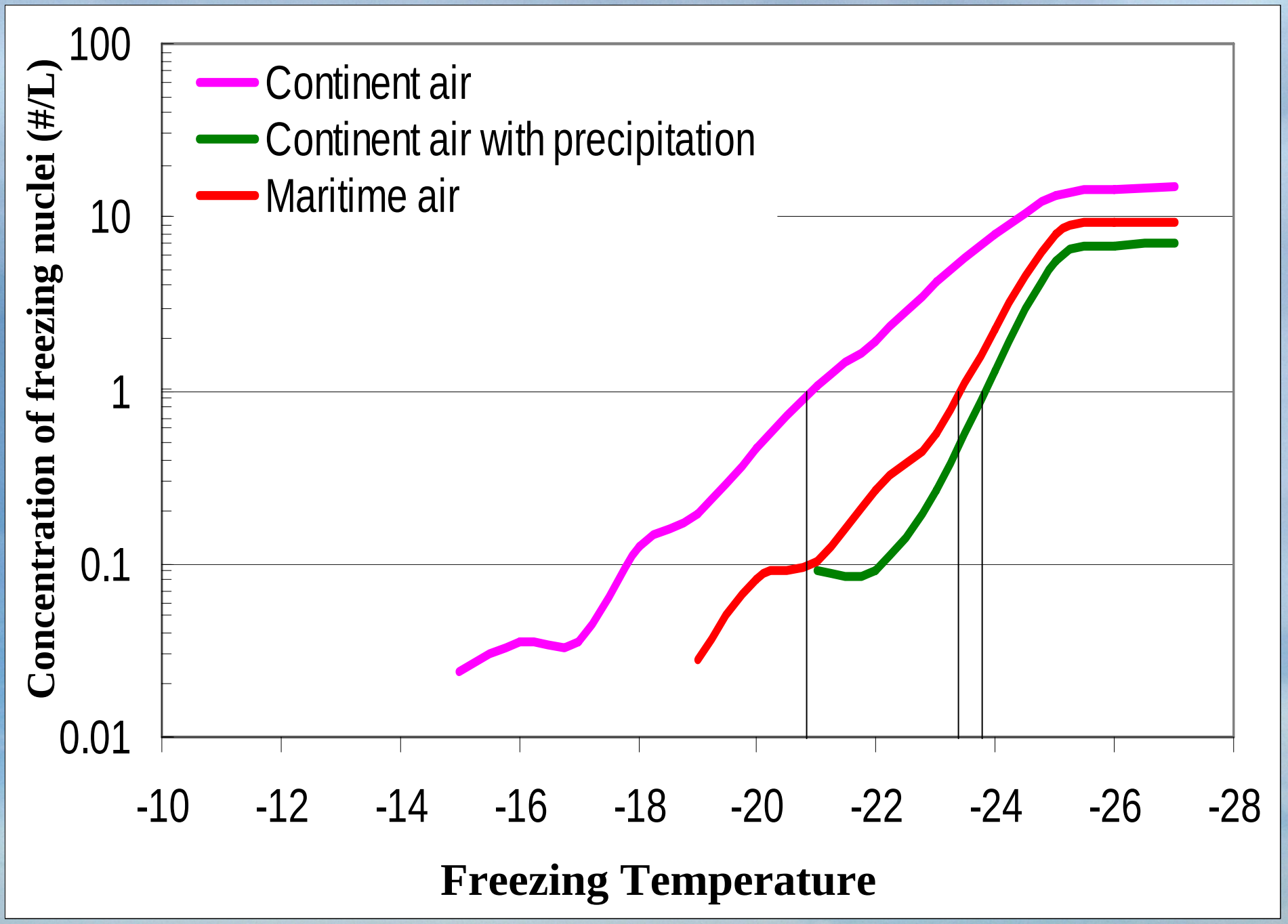
Comparison between measurements taken on the rooftop and with balloon





CPC
(>0.01 microns)

Nephelometer
(>0.1 microns)


Continent air
Continent air with precipitation
Maritime air
Concentration of freezing nuclei (#/L)
100
10
1
0.1
0.01
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
Freezing Temperature

Conclusions:

- Freezing Nuclei (FN) were found to be effective from -12ºC down to -27ºC, with concentrations of 0.05 to 26.3 #/L, respectively.
- Higher concentrations of effective FN were found in the samples collected on the balloon as compared to those measured on the rooftop.
- More effective IN were found on days with large aerosols.
- More IN were found when the air spent a long time (> 72 hours) over the continent as compared to air mass that originated over the Ocean and spent a less time over the continent.
- Average concentrations of about $1L^{-1}$ at -22ºC are somewhat lower than the classical value of $1L^{-1}$ at -20ºC (Big and Stevenson,1969) from average measurements around the world.

Thank You

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